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The Polyporaceae of North America—VIII. Hapalopilus, Pycnoporus, and new monotypic genera

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HAPALOPILUS Karst. Rev. Myc. 3: 18. 1881

This genus was established upon a single species, *H. nidulans* (Fr.), the chief distinguishing characters being an anoderm surface and fleshy-tough context. In his work on Finland basidiomycetes published in 1889 Karsten reduces *Hapalopilus* to a subdivision of the genus *Inonotus*, throwing white-spored and brown-spored forms together. The forms treated under this genus in the present paper are all white-spored, with anoderm, variously marked surface and corky substance. The prevailing color is some shade of brown, the context usually being ferruginous. All the species are dimidiate, sessile and imbricate and grow upon decaying wood. *H. sublilacinus* differs from the other species in growing upon coniferous instead of deciduous wood.

In distribution the species differ widely. *H. rutilans* occurs rather abundantly in the temperate regions of North America and Europe, *H. gilvus* is exceedingly common throughout North America in both temperate and tropical regions and *H. licnoides* is a common tropical American species. The other three are as yet known only from their type localities, which are southern. A very evident line of division exists between *H. rutilans* and the other species, which latter bear distinct evidence of recent common origin. When the great variability of *H. gilvus* is taken into consideration, it appears to be only a question of a comparatively short time before several new species will be evolved.

[The preceding number of the BULLETIN, Vol. 31, No. 7, for July, 1904 (31: 367-414,) was issued 29 July, 1904.]

Synopsis of the North American species

1. Hymenium concolorous, pileus smooth, entirely devoid of zones or furrows, context soft and friable, spores 2.5 × 3.5 μ. 1. *H. rutilans.*
Hymenium differently colored, pileus rarely smooth, context rigid or corky, not friable. 2.

2. Hymenium lilac-colored, tubes 1 cm. or more in length, pileus concentrically sulcate. 2. *H. sublilacinus.*
Hymenium dark brown, tubes less than 0.5 cm. in length, pileus smooth or zonate. 3.

3. Context rigid, pileus azonate or with few and indefinite markings. 4.
Context flexible, pileus plainly and definitely multizonate. 3. *H. licnoides.*

4. Context bright ferruginous, hymenium fulvous to fuliginous, spores elongated, 6 × 2 μ. 4. *H. gilvus.*
Context pallid, hymenium subfulvous, spores subglobose to ovoid, 3–4 μ in diameter. 5. *H. fulvitinctus.*
Context brown, hymenium brownish-gray, pileus reddish-brown, finely hispid behind, spores ovoid, 3 × 3.5 μ. 6. *H. hispidulus.*

1. **Hapalopilus rutilans** (Pers.)

Boletus suberosus Bull. Herb. France, **11**: 354. *pl. 482.* 1791.
Not *B. suberosus* L. Sp. Pl. 1176. 1753.
Boletus rutilans Pers. Icon. et Descrip. 18. *pl. f. 4.* 1798–1900.
Polyporus nidulans Fr. Syst. Myc. **1**: 362. 1821.
Polyporus rutilans Fr. Syst. Myc. **1**: 363. 1821.
Hapalopilus nidulans Karst. Rev. Myc. **3**: 18. 1881.
Inonotus nidulans Karst. Finlands Basidsv. 332. 1889.

This species seems to have been described independently under different names by both Bulliard and Persoon, though the name assigned by the former had been previously used by Linnaeus. When Fries studied the plant he gave it the name *P. nidulans*, following it with Persoon's *P. rutilans*, which, he naïvely remarked, was perhaps a variety of *P. nidulans*. The two species were kept distinct by Berkeley, but he had little and poor material and evidently did not know them very intimately.

The plant appears to grow on most deciduous wood, being found on birch, dogwood, hazelnut, hickory, oak and other deciduous trees, with a preference in this country, perhaps, for hickory. Collections are at hand from Paris, *Patouillard;* Connecticut, *Underwood, Earle, White;* Pennsylvania, *Rau, Stevenson;* New York, *Underwood;* Kansas, *Cragin;* Iowa, *Macbride;* Greenland, *Rostrup;* Austria, *Bresadola.*

2. **Hapalopilus sublilacinus** (Ell. & Ev.)

Mucronoporus sublilacinus Ell. & Ev. Bull. Torrey Club, **27**: 50. 1900.

This species was collected by Langlois on pine logs in Louisiana and very doubtfully and provisionally assigned to *H. gilvus*. In some ways it does resemble that species, but it is larger, with concentrically furrowed surface and long, lilac-colored tubes. The spores are hyaline, but very distinct from those of *H. gilvus*.

3. **Hapalopilus licnoides** (Mont.)

Polyporus licnoides Mont. Pl. Cell. Cuba, 401. *pl. 16. f. 2.* 1842.
Polystictus licnoides Fr. Nov. Symb. 92. 1851.
Polystictus subglaber Ell. & Macbr. Iowa Univ. Bull. Nat. Hist. **3**: 193. 1896.

This well-known fungus is exceedingly common in tropical parts of America, occurring on dead wood of various kinds and presenting a variety of forms according to locality and habitat. The best early description of it is that made by Montagne. Fries may have described the species under *P. crocatus*, but this is not yet well determined. According to Romell, *Polyporus xerophyllaceus* Berk. (Hook. Jour. Bot. **8**: 200. 1856), described from Brazilian collections, is a synonym of the present species. Specimens from Guadaloupe in the Paris herbarium are named *Fomes Khortalsii* Lév., which latter is a Sumatran species. Young plants collected in Nicaragua by C. L. Smith have recently received the name *Polystictus subglaber*, said to differ from *P. licnoides* in having smaller pores and no spines. Resupinate forms from the southern states are usually known as *P. crocatus*, possibly because this species was once so identified from South Carolina.

In many ways *H. licnoides* and *H. gilvus* are strikingly alike and approach very near to each other in some varieties, but they are usualiy readily distinguished by the numerous concentric zones which ornament the surface of the former species. Spores and cystidia correspond closely. *H. gilvus* extends much farther north, however, and is abundantly collected where *H. licnoides* is never found. Among the numerous collections of this species examined are the following: Jamaica, *Underwood, Earle;* Cuba, *Underwood & Earle;* Mexico, *Smith;* Nicaragua, *Smith;* Louisiana, *Langlois;* Florida, *Martin, Calkins, Lloyd.*

4. **Hapalopilus gilvus** (Schw.)

Boletus gilvus Schw. Syn. Fung. Car. 70. 1818.
Polyporus gilvus Fr. Elench. Fung. 104. 1828.
Polyporus calvescens Berk. Ann. Nat. Hist. **3**: 390. 1839.
Polyporus omalopilus Mont. Pl. Cell. Cuba, 423. 1842.
Polyporus carneofulvus Berk. in Fries, Nov. Symb. 68. 1851.
Polystictus purpureofuscus Cooke, Grevillea, **15**: 24. 1886.

Owing to the abundance and wide distribution of this species in America it has figured in many collections and received several different names. This renaming has been due partly to the ignorance of foreign botanists and partly to the importance which varieties assume when studied apart from abundant representative material. The type specimens grew on maple and sweet gum in the Carolinas, where the plant is still found in great abundance. Old specimens from New Orleans were so changed in appearance that Berkeley described them as *P. calvescens*. The thinner tropical form collected in Cuba was called *P. omalopilus* by Montagne, while the stratified form occasionally assumed under tropical conditions is known as *Polyporus carneofulvus* Berk., or *Polyporus holosclerus* Berk. Still another variation, sulcate, thicker and tinged with purple, was collected on hickory in South Carolina (*Ravenel 3034*) and described by Cooke as *P. purpureofuscus*.

In addition to the above specific names, other names with which we have nothing to do have been assigned to our plant, thus increasing the confusion; as, for example, *P. scruposus* Fr., *P. isioides* Berk. and *P. pruinatus* Berk. & Kl., all applied originally to Indian or African species.

The present species is too well known to American mycologists to require further description. It is found on decayed wood of deciduous trees throughout; and except in the Gulf states and south where *H. licnoides* occurs it need not be confused with other species. Collections are at hand from Canada, *Dearness;* Pennsylvania, *Barbour, Sumstine;* Delaware, *Commons;* New York, *Earle, Burnham, George, Underwood, Murrill;* New Jersey, *Ellis, Murrill;* Missouri, *Demetrio;* Ohio, *Selby, Morgan;* Kansas, *Cragin;* Wisconsin, *Baker;* Nebraska, *Clements, Williams;* Virginia, *Murrill;* Georgia, *Harper, Ricker;* Alabama, *Earle, Baker;* Florida, *Calkins;* Louisiana, *Langlois;* Mexico, *Smith;* Cuba,

Earle, Underwood; Jamaica, *Earle, Underwood;* Porto Rico, *Earle;* Trinidad, *Lloyd.*

5. **Hapalopilus fulvitinctus** (B. & C.)

Polyporus fulvitinctus B. & C. Jour. Linn. Soc. Bot. **10**: 313. 1868.

This species was collected on dead wood in Cuba by Wright. It differs from *H. gilvus* chiefly in having smaller and more rounded spores and paler substance; while in surface characters and consistency the two species are much alike. I know of no collections of the plant except those at Kew, and our knowledge of its habits and distribution is most meagre.

6. **Hapalopilus hispidulus** (B. & C.)

Polyporus hispidulus B. & C. Jour. Linn. Soc. Bot. **10**: 319. 1868.

Collected on decayed wood in Cuba by Wright. Known only from the rather scanty type collections at Kew. Pileus reddish-brown, finely hispid except near the margin, context brown, hymenium brownish-gray, spores ovoid, smooth, hyaline, $3 \times 3.5\ \mu$, immature, hyphae very pale ferruginous.

SPECIES INQUIRENDAE

Polyporus crocatus Fr. Epicr. 477. 1836–1838. Described from Leibman's Mexican collections. Transferred to *Polystictus* in Novae Symbolae, 91.1851. Probably a form of *P. licnoides* Mont. I hesitate to reduce *P. licnoides* to synonymy, however, without further investigation.

Polyporus sordidus Berk. in Fries, Nov. Symb. 80. 1851. Name changed to *Polyporus sordidulus* in Cooke's enumeration of polypores owing to the discovery of another species bearing the former name.

Polyporus endozonus Fr. Nov. Symb. 54. 1851. Collected by Oersted on trunks in the Island of San Juan. I have not seen the type of this species. It is said to be very thick and narrow, with smooth, rigid pileus, roughly fibrous context and very small short pores, which become dark umber with age. Fries treats it next to *P. scruposus* and it is certainly not far from *H. gilvus*, but the pileus is too thick and the substance too fibrous for this species.

PYCNOPORUS Karst. Rev. Myc. 3: 18. 1881

This genus was founded upon a single species, *Pycnoporus cinnabarinus* (Jacq.), and characterized by its author as follows: "Pileus suberosus, intus floccosus. Pori sat firmi." In North America there are two species of the genus, both of them very attractive, abundant and well known. One occurs chiefly in temperate regions and the other is extremely common in the tropics. In the southern United States the two approach quite near each other in some of their forms so that it is not easy to distiuguish them.

Synopsis of the North American species

Pileus thick smooth, opaque; plant abundant in temperate regions.
1. *P. cinnabarinus.*

Pileus thin, often zonate, brilliant red; plant abundant in the tropics.
2. *P. sanguineus.*

1. PYCNOPORUS CINNABARINUS (Jacq.) Karst. Rev. Myc. 3: 18. 1881

Boletus cinnabarinus Jacq. Fl. Austr. 4: 2. *pl. 304.* 1776.
Boletus coccineus Bull. Herb. France, 364. *pl. 501. f. 1.* 1791.
Polyporus cinnabarinus Fr. Syst. Myc. 1: 371. 1821.
Trametes cinnabarina Fr. Nov. Symb. 98. 1851.

This species was known for some time in Europe before receiving the name assigned to it by Jacquin. The type specimens were sent from Carinthia by Wulfen, and Jacquin states that it is parasitic on trees in subalpine districts of Austria. It is now known to occur on various deciduous trees in Europe, Asia and North America. Bulliard's fine figures were made from plants growing on cultivated cherry. Fries assigned it to his new genus *Trametes* in 1851 and Saccardo has listed it under two genera in his Sylloge. Its nearest ally is *P. sanguineus*, a tropical species, from which it differs in being thicker, more opaque in color, anoderm, and in having larger tubes with thicker dissepiments. There is also no zonate form of *P. cinnabarinus.*

The sporophores appear in this latitude in the latter part of June and mature quickly. In the earlier stages they are very soft, spongy and elastic, light orange in color and clothed with numerous slender delicate hairs which give them a pruinose appearance. Later the hairs disappear, the color becomes darker

and the margin thicker. Not infrequently the old sporophores revive and take on an additional stratum of tubes, the new growth extending outward and upward over the former margin so as to entirely conceal it from view.

Exsiccatae: Finland, *Karsten;* New York, *Clinton, Blake, Murrill;* New Jersey, *Anderson;* Pennsylvania, *Barbour, Sumstine, Stevenson;* South Carolina, *Ravenel;* West Virginia, *Nuttall;* Virginia, *Murrill.*

2. **Pycnoporus sanguineus** (L.)

Boletus sanguineus L. Sp. Pl. ed. 2. **2**: 1646. 1762.
Xylometron sanguineum Paul. Icon. Champ. *pl. f. 3, 4.* 1793.
Polyporus sanguineus Mey. Fl. Esseq. 304. 1818.
Polystictus sanguineus Fr. Nov. Symb. 75. 1851.

This highly attractive fungus has been known from ancient times on account of its great abundance and brilliant coloring. The type locality is given by Linnaeus as Surinam, South America, but herbaria are abundantly supplied with it from most tropical regions the world over. Paulet's figure is cited only because of his generic name; no drawing could be poorer than this one, which seems to be only a mechanical design for the corner of his plate, resembling the plant in color but in no other way.

As to habitat and host, this species exhibits little choice, occurring on standing or fallen dead trunks and structural timbers of almost any kind of deciduous or evergreen tree. According to Swartz, it was formerly eaten by the negroes in its young stages; but it is certainly too tough for any ordinary use in this way.

Of the large number of exsiccati examined, I need mention only a few: North Carolina, *Raasloff;* South Carolina, *Ravenel, Du Bois;* Georgia, *Frank, Harper;* Florida, *Lloyd, Small & Carter;* Cuba, *Underwood & Earle, Britton, Shafer;* Jamaica, *Earle;* Porto Rico, *Howe;* Hayti, *Nash;* San Domingo, *Wright;* Bahamas, *Minns;* Trinidad, *Lloyd;* Mexico, *Smith;* Nicaragua, *Smith;* Honduras, *Wilson;* Columbia, *Baker;* Uruguay, *Lorentz;* Paraguay, *Balansa;* Bolivia, *Rusby;* Peru, *Pearce;* Bonin Islands, *Wright.*

Abortiporus gen. nov.

Hymenophore annual, tough, humus-loving; stipe normally central, often obsolete; context yellowish-white, duplex, spongy

above, woody below, tubes thin-walled, mouths polygonal; spores subglobose, smooth, hyaline.

The type of this genus is *Boletus distortus* Schw. (Syn. Fung. Car. 71. 1818), a very variable species found about old stumps in various localities in the Eastern United States. The name assigned to the genus refers to the usual aborted form of the fruit body, in which the tubes with their abundant contents appear prematurely before the development of the pileus is complete.

Abortiporus distortus (Schw.).

Boletus distortus Schw. Syn. Fung. Car. 71. 1818.
Polyporus abortivus Peck, Bot. Gaz. **6**: 274. 1881.

The ordinary form of the fruiting body of this species has the appearance of being badly aborted in its development, only a few of the pilei reaching their full size. In its arrested form the pileus is a mass of pores filled with spores. The species has been badly confused with *P. rufescens* of Europe, but a study of that species in the field easily shows a very marked difference. A small specimen of our plant is to be found in the Paris herbarium under the name of *Polyporus pulvillus* Mont., but this name was never published for it so far as I know. The specimen is from South Carolina.

This species occurs about stumps, roots and other dead wood of deciduous trees, such as the oak, maple, *Ailanthus*, etc. Its distribution is quite general throughout the eastern part of North America and it has been found as far west as Wisconsin and Texas.

Exsiccatae: Canada, *Dearness;* Connecticut, *Earle;* Delaware, *Commons;* New Jersey, *Ellis;* Pennsylvania, *Rau, Gentry, Herbst;* Ohio, *Lloyd, Morgan, Dawson;* Missouri, *Demetrio;* Wisconsin, *Miss Patterson;* Alabama, *Earle & Baker;* Louisiana, *Langlois;* Texas, *Gentry.*

Cyclomycetella gen. nov.

Hymenophore annual, tough, epixylous, sessile, anoderm, zonate; context thin, fibrous, brown, tubes short, thin-walled, mouths polygonal, becoming concentrically elongated in some species by the splitting of the radial walls; spores ellipsoidal, smooth, ferruginous.

This genus is based upon *Boletus pavonius* Hook. (Kunth, Syn. Pl. **1**: 10. 1822), described from Colombia. Its nearest ally is the old-world genus *Cyclomyces*, erected by Fries in 1830 upon *Cyclomyces fuscus*. In this latter genus the tubes are continuous concentric furrows, while in the species of *Cyclomycetella* which come nearest to *Cyclomyces* the concentric appearance of the hymenium is caused by the partial splitting of the radial walls in age; and the formation of furrows is by no means constant.

Cyclomycetella pavonia (Hook.).

Boletus pavonius Hook. in Kunth, Syn. Pl. **1**: 10. 1822.
Polyporus pavonius Fr. Epicr. 477. 1836–1838.
Polyporus iodinus Mont. Ann. Sci. Nat. II. Bot. **16**: 108. 1841.

The type plants of Hooker's species were collected by Humboldt in Colombia, or New Granada as it was then called, and named for *Ulva pavonia* because of the concentric lines of the pileus. Montagne's types were from Guiana, collected by Leprieur. He first thought that these plants were *P. striatus* (Hook.), but later placed them midway between this species and *P. tabacinus* Mont., making no mention of Hooker's other species, *P. pavonius*, described just before.

Other closely related species are found in South America. *B. striatus* Hook. (Kunth, Syn. Pl. **1**: II. 1822), was described from plants collected by Humboldt in Peru, and has since been found in Venezuela. *P. vespilloneus* Berk. (Hook. Jour. **8**: 1856) was described from Juan Fernandez Island and later reported by Montagne from Chile. All these species show very recent common origin. *P. Hasskarlii*, a Ceylon species, has several times been erroneously reported from Cuba.

Cycloporus gen. nov.

Hymenophore annual, tough, anoderm, terrestrial, orbicular, centrally stipitate; context soft, spongy, ferruginous; pores at first polygonal, soon becoming continuous concentric furrows, dissepiments thin, lamelloid; spores ovoid, smooth, ferruginous.

The type of this genus is *Cyclomyces Greenei* Berk. (Lond. Journ. Bot. **4**: 306. *pl. 11.* 1845), a very rare plant found in temperate regions of North America. The genus *Cycloporus* differs widely from *Cyclomyces* in being terrestrial and stipitate instead of epixylous and sessile.

Cycloporus Greenei (Berk.)

Cyclomyces Greenei Berk. Lond. Jour. Bot. **4**: *pl. 11.* 1845.

This remarkable plant has been eagerly sought for by collectors since its discovery in New England by Greene and still the number of specimens found is hardly a dozen. It may at once be distinguished from all other pore-fungi by its concentric, gill-like tubes and central stem. It grows on the ground in woods. Specimens have been examined from Massachusetts, *Greene, Sprague;* New York, *Peck;* Connecticut, *Earle;* New Jersey, *Gentry;* Iowa, *McBride;* West Virginia, *Nuttall;* Vermont, *Farlow.* Five of these collections are in the herbarium of the New York Botanical Garden.

Globifomes gen. nov.

Hymenophore large, woody, encrusted, perennial, epixylous, compound; context ferruginous, punky, tubes cylindrical, thick-walled, stratose: spores ovoid, smooth, ferruginous.

The type of this genus is *Boletus graveolens* Schw. (Syn. Fung. Car. 71. 1818), a rather rare plant first found in Georgia and the Carolinas, but later discovered as far west as Iowa. The genus is readily distinguished among its allies by its compound pileus, which consists of numerous small, closely imbricated pileoli united into a compact rounded mass.

The genus *Xylopilus* of Karsten (Hattsv. **2**: 69. 1882), is also described as having a compound pileus, but *Xylopilus crassus* (Fr.) Karst., its type species, is very probably only an abnormal form of a European species of *Elfvingia;* and even if this type plant were found to be normal the genus *Globifomes* would remain sufficiently distinct.

Globifomes graveolens (Schw.)

Boletus graveolens Schw. Syn. Fung. Car. 71. 1818.
Polyporus conglobatus Berk. Lond. Journ. Bot. **4**: 303. 1845.
Fomes graveolens Cooke, Grevillea, **13**: 118. 1884.

This species was first sent to Schweinitz from Georgia, but was later found in North Carolina. Plants sent from Ohio to Berkeley were thought to differ sufficiently from those growing on oak to justify a new name. The heavy odor of the fruiting plant is

thought to be responsible for the common name of "Sweet Knot," by which it is known in some sections.

The most common host of this species is the oak, especially *Quercus nigra;* but it also occurs on beech. The fruit bodies are found on old dead trunks.

Exsiccatae: Rav. Fung. Car. **3**: 8; Ell. N. A. Fung. 603; Ohio, *James, Cheney;* Iowa, *Macbride;* Pennsylvania, *Sumstine.*

Nigrofomes gen. nov.

Hymenophore large, perennial, epixylous, sessile; context woody, purple, tubes cylindrical, stratose, thick-walled, black; spores ovoid, smooth, hyaline.

The type of this genus is *Polyporus melanoporus* Mont. (Pl. Cell. Cuba, 422. 1842), found on trunks of trees in tropical America. The genus is readily distinguished from its near allies by its purple context and black tubes.

Nigrofomes melanoporus (Mont.)

Polyporus melanoporus Mont. Pl. Cell. Cuba, 422. 1842.

This species is the darkest-colored of the perennial polypores. It was first described from collections made in Cuba by Ramon de la Sagra. Underwood has also collected it several times in Jamaica and Florida and Smith has found it in Nicaragua. It is probably more or less common throughout tropical America on decaying trunks of various broad-leaved trees.

Poronidulus gen. nov.

Hymenophore annual, tough, sessile, epixylous, at first sterile and cup-like, the fertile portion developing from the sterile; context white, fibrous, tubes short, thin-walled, mouths polygonal; spores ellipsoidal, smooth, hyaline.

The type of this genus is *Boletus conchifer* Schw. (Syn. Fung. Car. 72. 1818), a very common and abundant species on dead elm branches. The development of the fruit-body is peculiar, being in two stages, the first ending with the formation of a cup-shaped sterile body, from which the fruit-body proper later develops. This preliminary pileus begins as a knot of whitish mycelium,

which soon ceases to grow at the center, while the hyaline borders continue to grow upward and form a cup resembling species of *Nidularia*. The margin of the cup is thin and entire or undulate and becomes darker like the center when the limit of growth is reached, while the concentric zones within very plainly show the progress of the development. The cup varies from deeply infundibuliform to shallow or even flat at times and the central portion which has ceased to grow is much cracked radially to accommodate itself to the growing exterior.

The pileus proper usually arises from one side of the cup near its base and expands laterally into a reniform, zonate hymenophore considerably larger than the sterile portion. At times the pileus does not develop beyond the surface of the cup and at other times a developed pileus becomes proliferous at several points and give rise to new sterile and fertile portions. Since the formation of the cups continues throughout the growing season, many are overtaken by winter and are found among the new ones the following spring. The old pilei rarely remain over winter, being fragile and readily devoured by insect larvae.

Poronidulus conchifer (Schw.)

Boletus conchifer Schw. Syn. Fung. Car. 72. 1818.
Boletus virgineus Schw. Syn. Fung. Car. 72. 1818.

This species was first described from North Carolina, but it is known to be common in many parts of North America on fallen branches and dead limbs of the elm, its only host. Under the first name Schweinitz described forms that showed the cups attached to the developing pilei; under the second he placed fully developed fruit bodies showing little trace of the sterile part from which they sprang. The plant is confined to North America. Among collections examined are the following: Massachusetts, *King;* Connecticut, *White;* New Hampshire, *Minns;* New York, *Earle, Murrill;* New Jersey, *Earle, Murrill;* Ohio, *Lloyd;* Virginia, *Murrill;* Alabama, *Earle;* Kansas, *Bartholomew.*

A brief synopsis of the genera treated in articles I-VIII of this series

Surface of hymenophore covered with reddish-brown varnish, context corky. *Ganoderma.*

Surface of hymenophore not as above, or, if so, context woody.

Hymenophore annual.

Tubes hexagonal and radially elongated. *Hexagona.*

Tubes not as above.

Hymenophore stipitate.

Stipe compound. *Grifola.*

Stipe simple.

Context white.

Plants fleshy, terrestrial. *Scutiger.*

Plants tough, epixylous.

Pileus inverted, erumpent from lenticels. *Porodiscus.*

Pileus erect, not erumpent.

Context homogeneous, firm. *Polyporus*

Context duplex, spongy above, woody below. *Abortiporus.*

Context brown.

Hymenium concentrically lamelloid. *Cycloporus.*

Hymenium poroid.

Spores white. *Romellia.*

Spores brown.

Pileus erect, stipe central. *Coltricia.*

Pileus inverted, pendent. *Coltriciella.*

Hymenophore sessile.

Context white.

Tubes at length separating from the context, surface smooth. *Piptoporus.*

Tubes not separating from the context, surface zonate. *Poronidulus.*

Context red. *Pycnoporus.*

Context brown.

Spores white. *Hapalopilus.*

Spores brown. *Cyclomycetella.*

Hymenophore perennial.

Context and tubes white or pallid.

Hymenium at first concealed by a volva. *Cryptoporus.*

Hymenium free from the first. *Fomes.*

Context and tubes brown or dark red.

Hymenophore subsessile, caespitose, the numerous pileoli arising from a common trunk or tubercle. *Globifomes.*

Hymenophore truly sessile, either simple or imbricate.

Pileus covered with a horny crust, context punky. *Elfvingia.*

Pileus not covered with a horny crust or, if encrusted, context hard and woody. *Pyropolyporus.*

Context and tubes dark purple or black. *Nigrofomes.*

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Note on the sexual generation and the development of the seed-coats in certain of the Papaveraceae

CHARLES H. SHAW

(WITH PLATE 15)

During the past two years the writer has mounted and examined material in some quantity of *Sanguinaria*, *Chelidonium* and *Eschscholtzia*. The facts in hand indicate that the embryo-sac phenomena do not widely depart from those described, for instance, in genera of the *Ranunculaceae*. The following are some of the facts observed.

Annual phases of Sanguinaria.—Material of *Sanguinaria* has been gathered at various seasons in order to obtain a complete view of the annual life-cycle. The flowers of the plant begin to be formed nearly a year before they appear, viz., in May of the preceding year, while the seeds of that season are becoming mature. The stamens develop more rapidly than the carpels. By August the anthers are well formed, with four-lobed outline in cross-section, and the sporogenous tissue is beginning to be differentiated from that of the anther-walls. Cell-division proceeds during autumn, the size of the anther as a whole meanwhile increasing. The cells lying toward the periphery of the sporogenous mass begin to degenerate and by November the spore-mother-cells are seen as richly filled cells lying among the more or less disorganized tapetal cells. In this condition the winter is passed. Division of the mother-cells begins very early in the spring. Material killed on February 4, 1903, after several days of very mild weather, shows figures of dividing nuclei. Development of the spores and the final formation of the anther-wall seem, as might be expected, to be somewhat controlled by the weather, but are completed during this period, between the renewal of growth and blooming. The ovules begin to appear about August as undifferentiated outgrowths of the placental tract, but development lags behind that of the anthers. The integuments are not developed till the close of winter, at the time when the micro-

spores are being formed from their mother-cells. No trace of the megaspore mother-cell is visible when growth is renewed in late winter. *Sanguinaria* is therefore in this respect like *Salix* and *Populus*, whereas certain other plants, most definitely *Epigaea* and *Erythronium*, have been observed to reach the mother-cell stage during the preceding season.

The division of the megaspore mother-cells and the formation of the embryo-sac take place during March and early April. Although the development of the microspores has kept far in advance, the flower at blooming is proterogynous. As is well known, the phases from pollination to maturity of seeds occur in April, May and June.

Structure of the pistil.—In *Sanguinaria*, *Chelidonium* and *Eschscholtzia*, an open canal leads from the ovary to the exterior. Hairy outgrowths of a kind with those of the stigma project into the passage but generally do not close it, and continue down the two placental ridges. Thus the hairy outgrowths of the stigma, of the interior of the stylar canal and of the placental ridges form a single continuous tract. This is highly developed in *Sanguinaria*, less so in *Chelidonium* and *Eschscholtzia*, but distinctly in all. The path of the pollen-tubes is among these hairs and the loose superficial cell-layers from which they spring. The tubes pass through the micropyle and penetrate the nucellus in the usual manner.

The embryo-sac.—The embryo-sac exhibits the typical number and arrangement of nuclei (PLATE 15, FIGURES 1 AND 2). The polar nuclei are often met with, lying close together. In the antipodal region are found features of interest. The antipodal cells reach an unusual size, and the nucellar cells in their vicinity acquire thickened walls. In *Eschscholtzia* the antipodals continue to enlarge for a brief period during the early formation of the endosperm nuclei and then decrease and disappear before the endosperm cells are cut out.

In *Chelidonium* (PLATE 15, FIGURE 2), the antipodals are relatively smaller than in *Eschscholtzia* but they persist longer and may be seen after walls have formed about the endosperm cells. For *Sanguinaria* also the statements in regard to *Chelidonium* hold true.

In all three forms the cells in the nucellus adjacent to the anti-

podals acquire thickened walls (PLATE 15, FIGURE 1). This tissue increases during the enlargement of the sac and the formation of the endosperm. It can scarcely be doubted that to this tract, together with the enlarged antipodals, some nutritive significance attaches.

The size of the nucleoli is noteworthy both in the nuclei of the embryo-sac and those of the surrounding cells. Practically all of the strongly staining substance of the nuclei is included in them. It is difficult to entertain any other idea than that these nucleoli embrace the chromatin.

DEVELOPMENT OF THE SEED-COATS IN SANGUINARIA

The integuments arise shortly after renewal of growth in the spring as two folds growing up around the nucellus. Each consists throughout most of its extent of three cell-layers (PLATE 15, FIGURE 3). Following is a description of the differentiation and destiny of each of these:

(*a*) *The secundine.*—The inner of the three cell-layers undergoes anticlinal division as the ovule enlarges, so that at the time when the egg-apparatus is formed the cells are still nearly isodiametric (PLATE 15, FIGURE 4). At this time they have the appearance of active cells with abundant protoplasm and well-developed nuclei. Very soon, however, their anticlinal division becomes less active and at the same time they are stretched by the expanding embryo-sac. By the time that the endosperm nuclei have spread to the wall of the embryo-sac this layer is losing its organization, and thereafter appears only as an ill-defined rudiment (PLATE 15, FIGURES 5 AND 6).

The middle layer of the secundine has almost from the first less protoplasmic contents. At the time of the completion of the egg-apparatus it appears highly vacuolated with larger cells and degenerating nuclei. This is the first of all the layers to break down, the cells losing their form shortly after fertilization.

The outer layer of the secundine does not become vacuolated to so great a degree as the one last named and it persists somewhat longer. But it shares the fate of the other layers of the secundine, appearing while the endosperm is forming only as a mass of distorted and fragmentary cell-bodies.

(*b*) *The primine.*—The persistent parts of the seed-coats are formed exclusively from this tissue. The inner layer is marked almost from the first by its richer contents of protoplasm and active nuclei (PLATE 15, FIGURE 3). Anticlinal division nearly or quite keeps pace with the swelling of the ovule, so that at the time of the completion of the egg-apparatus (PLATE 15, FIGURE 4) the cells are nearly or quite isodiametric. Shortly after that period a great anticlinal elongation takes place and this layer becomes the first in prominence as it is destined to be in importance of all the cell-layers (PLATE 15, FIGURE 5). From an early date a sort of cuticular layer is formed on its inner surface where it comes in contact with the secundine (PLATE 15, FIGURE 5). The cells continue to be well filled with protoplasm and to have prominent nuclei. About the time when endosperm cells begin to be cut out, crystals of calcium oxalate appear within this layer, and these later accumulate to a considerable degree. While the endosperm is maturing, their layer still further increases in size and becomes greatly indurated. It forms the most important part of the testa, exceeding in thickness all the other layers together (PLATE 15, FIGURE 6).

The middle layer of the primine undergoes both periclinal and anticlinal division so that in the later stages it is several cells deep (PLATE 15, FIGURES 4, 5, 6). All these cells become highly vacuolated, increase in size, and toward the last become compressed by the enlarging inner layer of the primine and almost disappear.

The outer layer of the primine undergoes comparatively few divisions and these are all anticlinal. Although the cells become much enlarged, they are not distorted by pressure nor in any way disorganized, and developing thick walls on every side, they constitute the outer hard and shining coat of the seed (PLATE 15, FIGURE 6). The caruncle arises just outside the vascular tissue of the raphe, and its enormous cells are thin-walled, but by no means poor in contents. Despite the ready ecological explanations advanced, the significance of this caruncle is still, to the writer at least, a mystery.

In *Eschscholtzia* the development of the integuments resembles that in *Sanguinaria*, but with the difference that the principal layer of the testa is composed of smaller cells which have relatively little induration.

In *Chelidonium*, however, a more considerable difference exists. Both primine and secundine persist and take part in the formation of the seed-coat. In fact the outer cell-layer of the secundine is rather the most indurated of the four or five cell-layers which give protection to the endosperm.

SUMMARY

In *Sanguinaria* the microspore mother-cells are formed during the season preceding blooming, but their division and the formation of the ovular integuments and of the embryo-sac occur after renewal of growth in the spring, just before blooming.

In *Sanguinaria*, *Chelidonium* and *Eschscholtzia* an open canal extends from the carpellary cavity to the exterior.

In the above-mentioned forms the antipodal cells are very prominent, especially so in *Eschscholtzia*, and the adjacent nucellar cells are thick-walled and rich in contents.

In *Sanguinaria* and *Eschscholtzia* the secundine eventually disappears and the inner cell-layer of the primine constitutes the most important element of the testa. In *Chelidonium* both primine and secundine persist and take part in the formation of the seed-coat.

Explanation of plate 15

All drawings were made with camera lucida. Figures 3, 4, 5 and 6 are drawn to the same scale.

FIG. 1. Embryo-sac of *Eschscholtzia*.

FIG. 2. Embryo-sac of *Chelidonium*.

FIG. 3. Section through the integuments of *Sanguinaria*, immediately after their formation; *a*, secundine, *b*, primine.

FIG. 4. The same at the time of completion of egg-apparatus. The middle layer of the primine has undergone division.

FIG. 5. The same at the time when endosperm cells are being cut out. The secundine is breaking down.

FIG. 6. The same at maturity of seed, showing the inner layer of the primine greatly enlarged and indurated and containing crystals of calcium oxalate.

Observations on the germination of Phoradendron villosum and P. californicum

W. A. Cannon

A few years since, when in California, I had the opportunity of studying the structure and noting certain physiological peculiarities of *Phoradendron villosum.** The study was confined almost entirely to mature forms, only a few relatively young plants were secured, and no seedlings were seen although I searched diligently for them. Neither was I successful in germinating the seeds. It is with the idea of supplementing that work with some account of the younger stages of the life history of the mistletoe that this sketch is presented.

Among other things I showed in the preceding paper that the spreading of the mistletoe in the host occurs in the cortex only, a fact well known,† and also that this takes place because the haustoria are supplied with secreting cells from which probably exudes a solvent capable of dissolving the cell-walls of the host. It however was noticed that not all of the host-tissues were affected by the haustoria. For instance, their enzymes were apparently incapable of dissolving the suberized walls of the cork as well as the lignified grit-cells in the cortex, and this may account in part for the fact that the haustoria do not penetrate into the woody central portion of the stem. Of course in the latter instance other questions enter, as for instance the necessary change in function of the haustoria to water-absorbing organs, but as regards the grit-cells there can be no doubt. These were frequently noted lying within the tissues of the parasite and completely enclosed by them, which means that at an early stage in the development of the plant the grit-cells, like the other and adjacent cortical cells of the host, came into contact with the solvent secreted by the

* The anatomy of *Phoradendron villosum* Nutt. Bull. Torrey Club, **28**: 374. 1901.

† Kerner and Oliver. Natural history of plants. **1**: 216. — Peirce. On the structure of the haustoria of some phanerogamic parasites. Ann. Bot. **7**: 317. 1893.

parasite, but they, with lignified walls, unlike the latter whose walls were unmodified, were unaffected by this fluid.

The question at once arises as to whether the seedlings of the mistletoe secrete enzymes which can dissolve suberized, cuticularized or lignified cell-walls, and thereby gain entrance into the host at nearly any point, or, as may be the case in the haustoria of mature plants, only unmodified walls are affected. Of course it may be that cuticularized walls can be dissolved and neither of the other two. I have no evidence to offer in the latter alternative, but it is noticeable that the mistletoe is almost never parasitic on itself* in spite of the fact, which will be given later, that the seedlings often germinate in contact with its own branches. Dr. MacDougal informs me, however, that several instances have been known of the parasitism of one loranth on another in Jamaica. The mistletoe is provided with a cuticularized epidermis with communication to the exterior through stomates only.

In the vicinity of the Desert Botanical Laboratory occur two species of mistletoe, *P. villosum* and *P. californicum*. The former has white berries and broad leaves, the latter has red berries and is nearly devoid of leaves. *P. villosum* occurs here mainly on the native ash and native cottonwood and appears to be quite like the California plant studied by me. The other species has a different habit of growth. It generally hangs from the branches of the host, and is found mainly on the cat-claw (*Acacia Greggii*), and mesquite (*Prosopis juliflora*). I have seen it also on palo verde (*Parkinsonia microphylla*); and I believe that it occurs on the creosote bush (*Covillea tridentata*), but I have not seen it on this plant.

The distribution of the mistletoe from tree to tree is likely always effected by the agency of birds, but its distribution in a tree may be brought about in another manner also, and thus it is frequently accounted for by the position of the older plants. In cases where infection has occurred on the higher branches of the host it frequently happens that numerous younger plants of the parasite will be placed directly under this pioneer, as if they

* In Kerner and Oliver's work, *l. c.*, it is said that on one occasion mistletoe, probably *Viscum*, was seen growing on *Loranthus*. It, however, is not clear whether the place where the *Viscum* seedling gained an entrance was cuticularized or suberized.

were derived from its seeds. This habit is of much use to the collector, since he has but to mark a tree in which a large bunch of mistletoe is growing in the top, and if there is sufficient growth beneath, he is sure to find at the proper time of the year an abundance of seedlings.

Thus it must frequently happen that the mistletoe seeds germinate without having been first passed through the alimentary tract of birds, and, in fact, although I did not determine more closely the conditions under which they best germinate, these do not appear to be other than that the seeds must be mature. A large amount of heat is not required, and also it may be that germination is not dependent on rains.

In February, March and April germinating seeds of both species of mistletoe were seen in great abundance. The seedlings were found on all portions of the mesquite, including leaves, and on cat-claw and ash. That is, the seeds germinated on the old bark at the base of the tree as well as on last year's growth. I observed them also on dead twigs that were detached from any tree, on mesquite thorns, and even on the mistletoe itself. Also seedlings of *P. californicum* were taken from branches of the ash whither the seeds had been carried by birds. It thus appears questionable whether the character of the substratum has any influence whatever on the germination of the mistletoe seeds.

It is of interest to note that the seeds of the mistletoe are for the most part ripe and fallen by the time the leaves of the host make their appearance. This has one great advantage to the parasite, namely, that of being better able to reach the twigs and branches of the host than would be the case when these members are covered with leaves. As it will be seen later this is especially important in the case of the mesquite and its mistletoe.

Although water may not be a factor in inducing the germination of the seeds, it may assist in their dissemination; however I have made no direct observation on this point. When the seeds fall and become attached to a branch, they are so firmly fastened by means of the adhesion to the branch of their viscid contents, that they are dislodged with difficulty (FIGURE 1). It is quite possible, and here again I have no proof of the truth of the statement, that the firmness of the attachment is of considerable importance

to the seedling in permitting it to press the tip of the radicle firmly against the host.

After attachment is secured, the radicle is sent out; it turns in most cases directly toward the host and comes into contact with

FIGURE 1. Seeds of *P. villosum*, showing manner of attachment to the cottonwood branch. The shaded area represents the viscid substance which glues the seeds to the host.

it, and not until then forms the expanded tip whose distal epithelium functions as the secreting organ. The color, form and size of the hypocotyl in the two species of mistletoe are unlike. The hypocotyl of *P. californicum* is slender, reddish in color and may

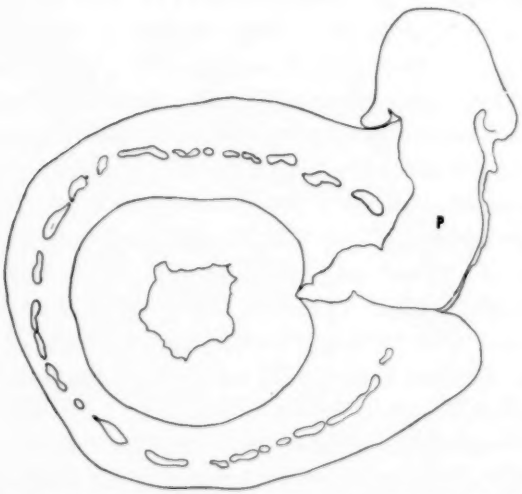

FIGURE 2. Seedling of *P. villosum* on cottonwood. This seedling penetrated last season; the tip of the haustorium is being transformed into a sinker for the absorption of water.

attain a length of .7 cm. although it is usually shorter. The hypocotyl of the other form is short, rarely much exceeding the seed-coat, stout and greenish in color. The structure of the hypocotyl in both is clearly like that of the mature plants, *i. e.*, the outer epi-

dermal wall is strongly cuticularized, and hence the hypocotyl is xerophytic. This not only ensures against rapid drying out but probably the converse of that, making impossible, perhaps, the absorption of water should it chance to come during the early stages of germination.

The cotyledons probably never emerge from the seed until foothold has been secured by the root, and this may not take place under several months from the time germination commences; they are thus unlike those of *Loranthus*, which appear much more quickly.* FIGURE 2 shows a young plant of *P. villosum* on a cottonwood branch. It was collected in January and the seed presumably was one that ripened and began to germinate the previous season. The seed-leaves, however, had not yet left the seed-coat; they were closely pressed together like the young leaves in old plants.

There are three well-marked periods in the life of the young mistletoe plant: 1, the growth of the hypocotyl and the formation of the disc; 2, penetration; and 3 (probably after the establishment of a connection with a water supply), the erection of the cotyledons.

Some very interesting work is to be done on the causes that influence the radicle to turn towards the host. In *P. villosum* this almost always occurs at once but in the other species the radicle may bend and twist in a variety of ways before the host is touched. However, in the end the tip of the radicle touches the substratum and flattens into a disc-shaped organ, likely as a result of the pressure caused by the resistance of the host.† The young disc was not especially studied; it has been long known that it secretes a substance which aids the penetration of the haustorium. The discs increase in size by the multiplication of cells about the periphery, and in older forms, in which penetration has already taken place, secreting cells of the disc are confined to the outer portion (FIGURE 3). These are as usual elongated, they have dense protoplasmic content and conspicuous nuclei.

Penetration is effected unlike in the two species, and in the instances cited, the manner of penetration is dependent on the

* Keeble. Loranthaceae of Ceylon. Trans. Linn. Soc. London, II. 5: 91. 1895.

† Compare the account given in Engler & Prantl, Nat. Pflanzenf. 3[1]: 160, and by Keeble, *loc. cit. supra*.

structure of the host. I would not say that the mistletoe does not gain entrance in these hosts in any other way, but I have seen nothing that would indicate that it does.

In the case of the ash, the mistletoe seeds, *P. villosum*, falling on the younger and smooth branches send out their hypocotyls and these attach themselves at once to the substratum. The branches are provided with prominent lenticels and if one of these chances to be directly beneath a disc, the epidermal cells of the disc enter it, dissolving or pushing to one side, or both, the cells of the host, and at length find themselves in the cortex. This is not a matter of solution entirely, since the host-cells at the side

FIGURE 3. Secreting cells at the edge of the disc of such a young mistletoe as that shown in the preceding figure. The cells are evidently active, but a study of the section from which the sketch was made does not show that the host tissues are being dissolved as the sketch would indicate.

of the haustoria give evidence of having been subjected to pressure by them, and the walls of such cells, as will appear directly, are suberized. That is, as far as I have been able to determine, and to express the matter in another way, the cell-walls of the host which make up the lenticels and which had been affected by the solvent, were not suberized, as is shown by the following tests. In the section from which FIGURE 4 was sketched, the walls of the host-cells which were immediately in front of the tip of the haustorium, and for a distance back equal to about one third of its length, gave the cellulose reaction with iodine and sulphuric acid; they were colored blue, while the lignified portions of the central

cylinder, the hard bast, as well as the suberized cork cell-walls were colored yellowish, the reaction for corky and for lignified tissue. And it was observed that the cell-walls of the host adjacent to the upper two thirds of the haustorium reacted to the test for suberized walls, and these were the cells which were seen to be compressed in a direction parallel to the surface of the haustorium, and which probably somewhat earlier had been moistened with the secretions of the haustorium. Naturally the cells nearer the tip of the haustorium, whose walls were of cellulose, gave no indications of pressure. It appears probable, therefore, that the entrance was made by pressing the loosely constructed tissue of the lenticel to one side, and afterwards, when the deeper cortical cells whose walls were of cellulose were reached, the solvents secreted by the haustorium became for the first time of service to the growing root by making the resistance of the host less, as well as by preparing the host-tissues for absorption.

FIGURE 4. *P. villosum* on ash. The haustorium is making its way between the hard bast of the cortex, but does not dissolve them. *p*, mistletoe; *cam*, cambium.

The general forms of haustoria which have penetrated in the manner above outlined, and on this host, as compared with those of the haustoria on the mesquite, point also to this conclusion. In the former the haustoria are most frequently wedge-shaped, in the latter they may be more or less spread out and brush-formed (FIGURE 4) and in the latter also there were no evidences of pressure exerted by the mistletoe on the host's tissues.

Penetration in the other species, it can thus be seen, takes place in quite another manner. This presumably, in part at least, is due to the differences in the structure of the branch of the two hosts. The axillary buds of the mesquite are closely enwrapped by protecting scales, and the internodal portions of the branch are

usually somewhat roughened and appear not to bear lenticels. Therefore the mistletoe seedling that would penetrate the mesquite branch must be able to make its way through the outer cork either by pressure or by dissolving the periderm, or entrance must be gained at some other point, as at the axillary buds. The latter solution of the problem has been made.

Even in older mistletoe plants it frequently happens that one can identify their place of attachment as being axillary, and in the younger ones the host sometimes sends out leaves from the same

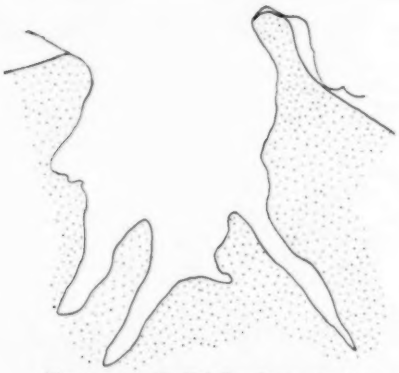

FIGURE 5. *P. Californicum* penetrating the cortex of the mesquite; the branching of the haustorium, which frequently may be seen, is shown.

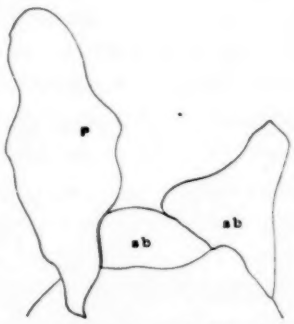

FIGURE 6. *P. Californicum* entering the cortex of the mesquite in the region of the axillary bud. *p*, mistletoe seedling; *sb*, the scale bases.

axillary buds. And I have seen branches of the mesquite on which as many as half-a-dozen successive buds bore mistletoes.

The manner of infection is as follows: seedlings which are attached to the internodal portion of the branch secrete solvents, as the discoloration of the cork immediately under the discs of the haustoria show, but they do not effect the penetration; such seedlings, however, as are attached either to the buds, or to the branch but close to them, and whose hypocotyls reach the buds, are those which at length gain admission into the sub-cortical host-tissues. The hypocotyls are pushed between the bud-scales to their base, the discs are formed in that position, and the secreting cells are thus brought at once in contact with cellulose cell-walls. These are penetrated without difficulty and, as mentioned above, apparently without exerting any pressure on the host (see FIGURE 5).

Although the method of securing an entrance into the hosts is in the two species of mistletoe and the two kinds of host plants above considered unlike in certain particulars, they agree in this, namely, that the solvents secreted by the haustoria of the parasite do not in either case dissolve suberized cell-walls, and apparently cannot do so. For this reason the points of admission open to the mistletoe are determined solely by the character of the host-substratum, whether its cells are loosely put together, as in the lenticels of the cottonwood, or the place where the parasite seeks admission has cellulose cell-walls.

Finally, it should be stated that the above conclusion is based on anatomical evidence alone, and that the subject should be taken up from the experimental standpoint before the conclusion can be definitely accepted as valid. And this experimental work I hope sooner or later to undertake.

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Two new species of American wild bananas with a revision of the generic name

ROBERT F. GRIGGS

At the time of publication of a former paper * I was not aware that antedating Linnaeus's application of the name *Heliconia*, to the plant called by the Indians "*Bihai*," is a description of the same plant under the name of *Bihai* by Adanson (Fam. Pl. **2**: 67. 1763). This necessitates the use of that name instead of *Heliconia*. It will be a matter of some pleasure to those whose sense of justice is gratified when they see the name given by the original describer of a plant retained, that *Bihai*, which was manifestly a generic name as first applied by Plumier, though not used binomially in the technical sense, can now be restored. Otto Kuntze, in his Revisio Generum Plantarum (**2**: 684. 1891), used Plumier's name with an *a* suffixed, probably to latinize it more perfectly; and applied it to all the species he knew. There were, however, several species which he overlooked, and it seems proper that these, together with a number of others described since his paper was published, should here be transferred from *Heliconia* to the older genus as follows: **Bihai aurantiaca** (Ghiesb.), **Bihai Bihai** (L.), **Bihai borinquena** (Griggs), **Bihai Burchellii** (Baker), **Bihai Champneiana** (Griggs), **Bihai choconiana** (Watson), **Bihai Collinsiana** (Griggs), **Bihai crassa** (Griggs), **Bihai distans** (Griggs), **Bihai elongata** (Griggs), **Bihai episcopalis** (Vell.), **Bihai humilis** (Jacq.), **Bihai latispatha** (Benth.), **Bihai librata** (Griggs), **Bihai lingulata** (Ruiz & Pavon), **Bihai platystachys** (Baker), **Bihai purpurea** (Griggs), **Bihai rostrata** (Ruiz & Pavon), **Bihai rutila** (Griggs), **Bihai spissa** (Griggs), **Bihai tortuosa** (Griggs). Each of these was originally described, with the same specific name, under *Heliconia*, by the author cited in parentheses.

The two species of *Bihai* described below were discovered by Messrs. Cook, Collins and Doyle of the United States Department

* On some species of *Heliconia*. Bull. Torrey Club, **30**: 641–664. December, 1903.

of Agriculture, in the spring of 1903. The types of both are in the herbarium of the Department of Agriculture at Washington.

Bihai reticulata sp. nov.

Leaf 94 cm. long, 37 cm. broad, petiole and base 70 cm.; blade elliptical, acute at the tip, cuneate at the base, thin, glabrous, not glaucous, main veins about 1 cm. apart, finest veins nearly 1 mm. distant, connected by cross-veinlets forming square meshes (an unusual character, for the veins of most species are so close together as to make the cross-veinlets so short that they are not often noticed even under a glass; this feature is strikingly brought out by the remarkable coloration of the under surface of the leaf); all the veins from the midrib down, including the cross-veinlets, bright red contrasting strongly with the body of the leaf and giving it a very noticeable screen-like appearance; inflorescence sessile, upright, about 25 cm. long, nearly if not quite glabrous, of 12–15 bracts; rachis stiff and straight; bracts close, overlapping at their middles, ascending at angles of 45–60°, lowest sterile bract 15 cm. long, 8 cm. broad, long-acute, the middle ones suborbicular, 8 cm. long, 10 cm. broad, rounded at the base, with a very short-acuminate tip; flowers large, longer than the branch-bracts, red and yellow (*fide* Cook).

Cook & Collins 149, Buena Vista, Costa Rica; *photo 5547*. Growing in a deep ravine.

This plant with its broad branch-bracts rather closely packed on the rachis, belongs to the subgenus *Taeniostrobus*. But its sessile inflorescence makes it unusual in that section. It is not close to any of the described species, differing from all either in the absence of a peduncle or in the inflorescence being much narrower with smaller bracts. It seems to be distinct also from all other species of the genus, whether of the same subgenus or not, in the colored venation of the leaves.

Bihai longa sp. nov.

Stem 6 m. long, inclined (*fide* Collins), leaf-surfaces radially disposed; leaves 1.5–2 m. long, about 50 cm. broad, acute, obliquely cordate at the base, rather thick and firm, glabrous except along the midrib, covered below with a bloom so extremely dense as to be as thick as the body of the leaf itself and to give the under surface a feeling like that of felt; petiole about 1 m. long; inflorescence pendulous, nearly 2 m. long, peduncle 25 cm., stout, glabrous; rachis flexuose, flexible, short-tomentose, inter-

nodes 2–6 cm.; bracts many, 27 in the type, all but the last one reflexed, ovate, acute, varying from 7 cm. long at the tip to 16 cm. at the base and from 5–8 cm. wide, tomentose on the outside, at least near the base, and densely ferruginous-pubescent within: flowers almost as long as the branch-bracts except at the base of the inflorescence, flower-bracts triangular, 2 cm. broad, 5 cm. long, densely velvety pubescent on the outside, glabrous within.

El Pez, road from Buena Vista to San Carlos Valley, Costa Rica, *Cook & Collins 47, photo 5459*.

The present species is closely related to *B. Collinsiana*, and probably more closely to *B. pendula*. From the former it is distinct in the hairy inflorescence, twice or three times as long, the stouter rachis, the ovate rather than lanceolate branch-bracts. From *B. pendula* it differs in being fully twice as large, in the very glaucous, not green, leaves, in the hairy not glabrous, broader, branch-bracts.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1901-1903)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers, at the rate of one cent for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card-issue should be addressed to the Treasurer of the Torrey Botanical Club.

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New species; native of Trinidad.

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